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Development of Hots (*Higher Order Thinking Skills*) Based Test Instrument on Stochiometry Materials for Class X Senior High School

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Abstract: Development of HOTS (Higher Order Thinking Skills) Based Test Instrument on Stoichiometry Materials for Class X Senior High School This study aims to develop a *Higher Order Thinking Skills* (HOTS) based test instrument on Stoichiometry material for X SMA students. The type of research used is *Research and Development* (R&D) using the ADDIE model which consists of five stages, namely Analysis, Planning, Development, Implementation, and Evaluation. The test instrument was validated by 4 experts, namely 3 Unimed chemistry lecturers, and 1 chemistry teacher using a validation question naire. Small group trials were conducted XI Natural Science 1 and large group trials were conducted X Natural Science 2 all students of State Senior High School 21 Medan *purposive sampling* technique Data analysis techniques for content validity using Microsoft excel and construct validity using Aiken's formula. The results showed that the instrument developed had good characteristics in terms of logical validity with a content validity index of 0.872 and construct validity of 0,91-1,00. The reliability coefficient of 0.81 is classified as very high. The data obtained shows that the *Higher Order Thinking Skills* (HOTS) based test instrument on stoichiometry material for SMA/MA students is valid and has good item quality. This is indicated by the overall high-level thinking ability of students has an average value of 66.54, with an average of 15 students answering questions correctly out of 23 questions In the category of high and very high value ranges of 61-100 produced 64% and for sufficient and low percentages with a range of values of 21-60 said added the resulting percentage is 36%. So That it is necessary to develop learning media using *problem-based learning* applications that improve student learning outcomes and it is concluded that the test instruments developed are feasible and effective for measuring students' HOTS.

Keywords: HOTS-Based Test Instrument, Higher Order Thinking Skills, Stoichiometry

Abstrak: Pengembangan Instrumen Tes Berbasis HOTS (Higher Order Thinking Skills) Pada Materi Stoikiometri X SMA. *Penelitian ini bertujuan untuk mengembangkan instrumen tes berbasis Higher Order Thinking Skill (HOTS) pada materi Stoikiometri untuk siswa X SMA. Jenis penelitian yang digunakan adalah Research and Development (R&D) dengan menggunakan model ADDIE yang terdiri dari lima tahap, yaitu Analisis, Perencanaan, Pengembangan , Implementasi, dan evalusi. Instrumen tes divalidasi oleh 4 orang ahli, yaitu 3 orang dosen kimia Unimed, dan 1 orang guru kimia dengan menggunakan angket validasi. Uji coba kelompok kecil dilakukan XI IPA 1 dan uji coba kelompok besar dilakukan X IPA 2 seluruh siswa SMA Negeri 21 Medan. teknik purposive sampling Teknik analisis data untuk validitas isi menggunakan Microsoft exel dan validitas konstruk menggunakan formula aiken's. Hasil penelitian menunjukkan bahwa instrumen yang dikembangkan memiliki karakteristik yang baik*

dari segi validitas logis dengan indeks validitas isi sebesar 0,872 dan validitas konstruk sebesar 0,91-1,00. Koefisien reliabilitas sebesar 0,81 tergolong sangat tinggi. Data yang diperoleh menunjukkan bahwa instrumen tes berbasis Higher Order Thinking Skills (HOTS) pada materi stoikiometri untuk siswa SMA/MA valid dan memiliki kualitas butir soal yang baik. Hal ini ditunjukkan secara keseluruhan kemampuan berpikir tingkat tinggi siswa memiliki nilai rata-rata sebesar 66,54, dengan rata-rata siswa menjawab soal sebanyak 15 butir soal dengan benar dari 23 soal secara keseluruhan pada kategori rentang nilai tinggi dan sangat tinggi 61-100 yang dihasilkan 64% dan untuk persentase cukup dan rendah dengan rentang nilai 21-60 bilang dijumlahkan yang dihasilkan persentase adalah 36%. Sehingga, diperlukanlah mengembangkan media pembelajaran dengan menggunakan penerapan pembelajaran problem based learning yang meningkatkan hasil belajar siswa dan disimpulkan bahwa instrumen tes yang dikembangkan layak dan efektif untuk mengukur HOTS peserta didik

Kata Kunci : *Instrumen Tes Berbasis HOTS, Higher Order Thinking Skills , Stoikiometri*

• INTRODUCTION

The Revised 2013 Curriculum is a form of developing a curriculum that is both character-based and competency-based in its execution, and it is introduced gradually in the 2017/2018 academic year, primarily at the primary and secondary school levels. The updated 2013 curriculum demands instructors to develop learning by combining four vital aspects, namely Strengthening Character Education (PPK), Literacy, 21st Century Skills (4C), and *Higher Order Thinking Skills* (HOTS), which require teacher ingenuity in concocting them. This is exactly what the 2013 Revised Curriculum aims to achieve, not simply the transfer of knowledge or content, but the building of 21st century competences. The integration of 21st century skills into learning in schools is very important, because 4C Creative thinking, Critical thinking and problem solving, communication, and Collaboration ability is a type of soft skill which is much more useful in daily implementation than just strengthening hard skills. (Darise, G.N. 2019)

Chemistry is a required subject in Senior High School (SMA). Chemistry is a discipline of science that is closely tied to everyday life and is centred on providing facts rather than notions, including the accompanying changes caused by chemical reactions. Stoichiometry is one of the materials in chemistry. Stoichiometric material necessitates a thorough understanding of chemical fundamentals as well as strong numerical ability. This is congruent with the qualities of the information in that chapter in the form of concepts concerning basic chemical principles and associated formulas, both compound formulas and calculation formulas.(Ulfa, D.K. 2018)

HOTS skills are a crucial element of the learning process and can influence student ability, speed, and effectiveness. HOTS is a future provision for students in the form of strategic competency and adaptive thinking in addressing problems in everyday life, therefore it becomes an important feature for the implementation of the 2013 Curriculum, as well as a necessity in preparing the 21st century generation. HOTS is a cognitive process that involves more than just recall, rephrase, or recite. Higher-order thinking skills are also defined as cognitive processes that try to produce solutions in difficult and confusing situations. Bloom's taxonomy categorises higher-order thinking skills into three levels: analysing (C4), evaluating (C5), and creating (C6). Cognitive processes that are classified as critical thinking are analyzing and evaluating, while

creating is classified as creative thinking. (Ismono, I. 2021)

Seeing this situation, it is necessary to develop and prepare test instruments to measure students' higher order thinking skills. In the form of multiple-choice questions, it is important for educators to provide questions with indicators capable of measuring students' *higher order thinking skills*. (Kurniati et. al., 2016).

Several previous studies regarding the development of *(Higher Order Thinking Skills*) based test instruments have been carried out by several researchers. The first research referred to by the author as a reference is research that has been carried out by (Silalahi, 2019) with the title "Development of Test Instruments Based on *Higher Order Thinking Skills* (HOTS) on Salt Hydrolysis Material at SMAS Muhammadiyah 2 Medan", it was found that to measure level thinking skills The height of the students used test instruments in the form of multiple choice with as many as 20 questions and 5 alternative answers. The cognitive domains of the questions are C4, C5, and C6. The construction of the test instrument based on expert judgement was deemed practicable based on the criteria of content validity with the Aiken V index ranging from 0.91 to 1.00 (highly valid category) and instrument reliability of 0.82 (very reliable category). As a result, it was determined that the level of high-level thinking skills of class XII MIA SMAS Muhammadiyah 2 Medan students on salt hydrolysis material ranges from 0-20 (very poor) to 60-80 (excellent). The results of 15 questions with valid criteria and five invalid questions were obtained. Which means the matter is reliable. For the level of difficulty, of the 20 questions developed, there are 7 questions with difficult criteria and 13 questions with medium criteria. As for the difference in questions, of the 20 questions developed, there are 6 questions with bad criteria, 11 questions with sufficient criteria, two good, and one very good.

Based on the background described above, there are 2 problem formulations in this study, namely, how to develop test-based instruments *Higher Order Thinking Skills* on stoichiometry material? What is the level of thinking ability of class X Natural Science students at State Senior High School 21 Medan in solving level questions *Higher Order Thinking Skills* on stoichiometry material?

• METHOD

This type of research is R & D (Research and Development). Research and Development is a type of research that examines the system design, development and evaluation of programs, processes and learning products that meet the criteria of validity, practicality, and effectiveness. The research was conducted at State Senior High School 21 Medan in the even semester of March 2022/2023 academic year in class X Natural Science Medan Tenggara Village, Medan Denai District, North Sumatra Province. By using the ADDIE development model which produces a product in the form of a HOTS-based test instrument (Higher Order Thinking Skills) on Stoichiometry material in senior high school (SMA).

The techniques and instruments used in this study were interviews, validation sheets, and tests that were compiled by researchers with the HOTS cognitive domain

(analyzing, evaluating, and creating) to obtain data on students' higher-order thinking abilities. The research data were analysed in phases to establish feasibility (validity) and students' thinking skills. The data from the validation results of the experts were analysed by considering, input, comments, and suggestions from the validator, which were utilised as a reference for updating the instrument established by the researcher. The validity of the instruments created can be noticed on the validation sheet filled out by the expert validator during the validation procedure. The degree of students' higher order thinking skills can also be demonstrated in the results of the students' higher order thinking skills test (HOTS).

- **RESULT AND DISCUSSION**

The Implementation of Test Instruments Stage

The implementation phase is carried out in a tiny class test. Small class trials were conducted on 36 students from class XI Natural Science 1 State Senior High School 21 Medan. Test instruments are delivered in class during chemistry courses directly (offline) with 30 questions in 90 minutes. The findings of this test are used to determine the viability of the HOTS test instrument that has been designed, which is based on an analysis of the validity, reliability, discriminating power, difficulty level, and effectiveness of the distractor on the questions

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Validity

The data were analyzed using the product moment correlation equation in rough numbers with the help of the Microsoft Excel program. Product moment correlation calculation results (r count) are compared to r_{table} with a significance level of 5%. Based on the results of the small class test validity analysis, 23 questions were valid, and 7 questions were invalid. Calculation results of the analysis of the validity of the test instrument on the small class test.

Reliability

The result of the small class test reliability test is 0.81 with a significance level 5%. These results indicate that the multiple-choice test instrument with a total of 30 questions is reliable because $r \geq 0.61$, with a high reliability category.

Difficulty Level

The findings of the analysis of the 30 questions assessed show that 10 questions are categorised as easy, 16 questions as intermediate, and 4 questions as difficult. The difficulty level of the questions in the small class test was calculated.

Difference Power

Based on the analysis of the differential power of the small class test items from the 30 questions examined, 10 questions were acquired in the good category, 11 questions in the sufficient category, and 9 questions in the bad category. The outcomes of a minor class difference power.

Effectiveness of Deceivers

The number of distractors that are effective if selected is at least 5% of the total test participants. Based on the analysis of the effectiveness of the item distractor in the

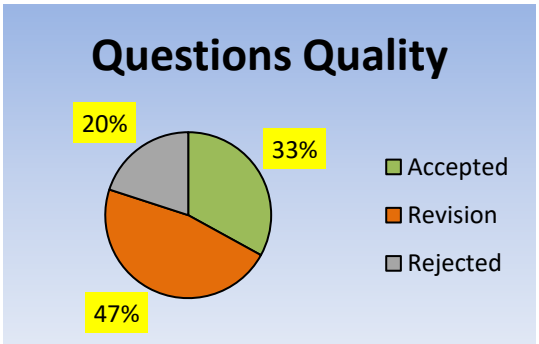
small class test, out of the 30 questions tested, 7 questions were obtained in the very good category, 13 questions in the good category, 4 questions in the moderate category, and 2 questions in the bad category. Calculation results on the effectiveness of the distractor in the small class test.

Interpretation of Small Class Test Results

Based on the interpretation of the quality of the items from the perspectives of validity, reliability, level of difficulty, discriminating power, and distractor effectiveness, it was discovered that 11 questions were accepted without revision, 10 questions were received with minor revisions, 3 questions were received with major revisions, and 6 questions were discarded. The findings of the interpretation of the test instrument's quality in the small class test.

Based on the data shown above, it is clear that 11 questions (33%) can be accepted and revealed to the large class test since they meet the criteria for validity, reliability, difficulty level, discriminating power, and detractor efficacy. There are 13 questions (47%) that still need to be altered because they do not meet one or more of the criteria for validity, reliability, difficulty level, discriminating power, and detractor efficacy. In addition, 6 questions (20%) were rejected and eliminated because they did not fulfil the predefined specifications.

Figure 1. Small Class Test Interpretation Pie Chart



Minor class test revision

Refinement of the initial test instrument was carried out after a small class trial with a qualitative approach. The results of the revision of the small class test are for refining the test instrument to be used for large class tests.

Higher Order Thinking Skills

The HOTS-based test instrument, which has been improved by researchers, will be tested in a large class, class XI Natural Science 1 State Senior High School 21 Medan. The total number of respondents is 36 students, with a total of 23 questions. The purpose of the study in big classes was to determine students' high-level thinking skills in Stoichiometry content. Table 1 displays the results of the data collection.

Table 1. Data on Students' Higher Order Thinking Ability in Completing HOTS-Based Test Instruments in Stoichiometry Material

Aspect	Value
Maximum Value	90
Minimum Value	35
Average value	66,54
Standard Deviation	19,20

According to table 1, the highest score achieved by all students in completing the HOTS-based test instrument on the reaction rate material is 90. The lowest score achieved by pupils is 35. All students' average score is 66.54, with a standard deviation of 19.20. This demonstrates that the total average value of pupils' higher-order thinking skills is high. The percentage of students with higher-order thinking abilities who completed the HOTS-based test instrument on the reaction rate material supplied in table 2 is shown below.

Table 2. Percentage of Students' Higher Order Thinking Ability

Value Range	Category	Absolute Frequency	Percentage
81-100	Very high	9	25 %
61-80	High	14	39 %
41-60	Enough	9	25%
21-40	Low	4	11%
0-20	Very low	-	-
Amount		36	100%

Based on the data shown above, it is possible to conclude that when students complete the HOTS-based test instrument on stoichiometry, 9 students (25%) fall into the extremely high category with a range of 81-100. There are 9 pupils (25% of the total) in the adequate group with a range of 41-60. Furthermore, 4 pupils (11% of the total) are in the low category with a range of 21-40. There are no pupils in the extremely low category with a range of 0-20. Based on these findings, the researcher concludes that no students had very low high thinking skills.

The following is the percentage of students' ability to answer the HOTS test instrument on Stoichiometry material based on the indicators presented in table 3.

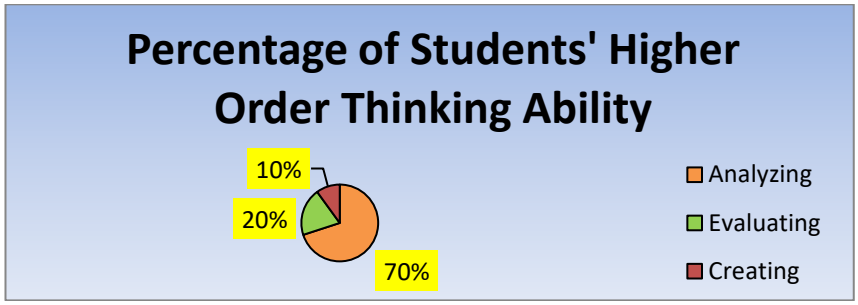
Table 3. Percentage of Students' Higher Order Thinking Ability Based on Indicators

Indicator	Percentage %
Analyzing (C4)	69,99%
Evaluating (C5)	20%

Creating (C6)	9,99%
Amount	100%

Based on Table 3 it is known that the largest percentage of students in answering HOTS questions is on the evaluating indicator (C5) of 20%. On the analyzing indicator (C4) it is 69.99%. While the lowest percentage is found in the percentage of creating indicators (C6), which is 9.99%.

Figure 2. Percentage Pie Diagram of Students' Ability to Answer HOTS-Based Test Instruments Based on Indicators



Students' Higher Level Thinking Ability According to Indicators on Stoichiometry Material

Analyzing

In terms of indicators, as many as 69.99% of learners were able to correctly answer questions from all students. This demonstrates that pupils who can respond correctly can also analyse the questions. Students can determine the notion of atomic mass and relative molecular mass, explain the basic laws of chemistry, analyse the concept of moles in compounds, and explain the concentration of a substance in percentage mass while doing chemical calculations based on experimental evidence. This is consistent with Widihastuti's (2014) research, which found that pupils at the analysis level can provide reasoning logically, methodically, and analytically. The results of this study were also supported by interviews conducted with State Senior High School 21 Medan teachers who said that during chemistry lessons the students' interest, seriousness, and participation in answering the questions posed by the teacher were quite high.

Evaluating

In evaluating indicators, as many as 20% of students were able to answer questions well from all students. This indicator has the highest percentage of other indicators. This demonstrates that learners have begun to assess and examine things that are relevant against things that are not relevant. Students can determine the notion of atomic mass, relative molecular mass, explain the basic laws of chemistry, analyse the concept of moles in compounds, and explain the concentration of a substance in percentage mass while doing chemical calculations based on experimental evidence. This is consistent with Widihastuti's (2014) research, which found that students at the evaluating level can solve issues properly and swiftly, as well as make sound conclusions.

Creating

In the creating indicator, as many as 9.99% of students were able to answer questions well from all students. Students who can answer questions with the C6 cognitive domain are considered capable of planning a procedure that must be carried out to solve a problem or create a new product. This demonstrates that students who can answer correctly can determine the concept variables of atomic mass and relative molecular mass, explain basic chemical laws, analyse the concept of moles in compounds, and explain substance levels in mass percentages when completing chemical calculations from experimental data served. This is consistent with Hasruddin's (2016) research, which states that higher order thinking can take the form of curiosity, open thinking, and skills such as analysing, drawing conclusions, and creating, namely producing a new product by organising several elements into a different shape or pattern than before.

• CONCLUSION

The proposed test instrument was a multiple-choice test with 30 questions, each with the cognitive domains of analyzing (C4), evaluating (C5), and creating (C6). Students' higher order thinking skills in Stoichiometry material in class X Natural Science of State Senior High School 21 Medan in the 2022/2023 academic year are included in the high category. This is based on the data as a whole. Students' higher-order thinking skills had an average score of 66.54, with the average student completing 15 questions correctly out of a total of 23 questions. In the category of high and very high value ranges of 61-100 produced 64% and for sufficient and low percentages with a range of values of 21-60 said added the resulting percentage is 36%.

• REFERENCES

Anggraini, N. P., (2019). Analysis of higher order thinking skills students at junior high school in Surakarta. *In Journal of Physics: Conference Series* 1211(1), p. 012077. IOP Publishing

Amelia, H., Mustika, W., & Sri, H., (2018). Pengembangan Instrumen Kognitif Untuk Mengukur Penalaran Siswa SMP di Kota Banjarmasin Pada Materi Cahaya. *Jurnal Berkala Ilmiah Fisika*, 6(1): 83-97.

Amne, D. P. F. (2020). Pengembangan Instrument Tes Berbasis HOTS (Higher Order Thinking Skills) Pada Materi Hidrolisis Garam. Skripsi, Pendidikan Kimia, Universitas Negeri Medan, Medan.

Darise, G. N. (2019). Implementasi Kurikulum 2013 Revisi sebagai solusi Alternatif pendidikan di Indonesia dalam menghadapi Revolusi Industri 4.0. *Jurnal Ilmiah Iqra'*, 13(2), 41-53

Dalman, R. P., & Junaidi, J. (2022). Penyebab Sulitnya Siswa Menjawab Soal HOTS dalam Pembelajaran Sosiologi di Kelas XI IPS SMAN 1 Batang Kapas Pesisir Selatan. Naradidik: *Journal of Education and Pedagogy*, 1(1), 103-112.

Holiwarni, B. (2016). Pengembangan Perangkat Penilaian Berbasis kelas untuk Pembelajaran Kimia Sekolah Menengah atas pokok bahasan Stoikiometri. *Jurnal Pendidikan Kimia Universitas Riau*, *1*(2), 9-16.

Ismono, I. (2021). Pengaruh Implementasi Model Pembelajaran Problem Solving

Dipadukan dengan Keterampilan Hots terhadap Hasil Belajar Peserta Didik Berdasarkan Studi Literatur. *UNESA Journal of Chemical Education*, 10(1), 10-19

Kistiono. (2019). Pengembangan Tes Kemampuan Berpikir Tingkat Tinggi Fisika SMA. *Jurnal Inovasi dan Pembelajaran Fisika*, 6(1): 70-81.

Khoririah, Tri, J., & Abdurahman. (2018). Developement Of Assesment Instruments Higher Order Thinking Skills On Science Subjects For Student Grade Eight Junior High School. The Online *Journl of New Horizons in Education*, 8(2): 19-29.

Lestari, Y. I & Titin S. (2020). Pengembangan Instrumen Tes Soal HOTS Untuk Mengukur Keterampilan Berpikir Kriti, Berpikir Kreatif, dan Pemecahan Masalah Materi Gerak Lurus Pada Peserta Didik SMA. *Jurnal Inovasi Pendidikan Fisika*, 9(2),76-82

Mulyatiningsih, E., & Nuryanto, A. (2019). Metode penelitian terapan bidang pendidikan. Bandung: Alfabeta, Departemen Pendidikan Nasional, Peraturan Menteri Pendidikan Nasional nomor, 41.

Napitupulu, N. M., & Yusuf, M. (2022). Pengambangan Instrumen Tes Berbasis HOTS (Higher Order Thinking Skills) Pada Materi Laju reaksi. *JS (Jurnal Sekolah)*, 6(3), 162-168.

Ningsih, I. S., & Kamaludin, A. (2022). Development of Textbooks with Higher Order Thinking Skills (HOTS) on Colligative Properties of Solutions. *Jurnal Pendidikan dan Pembelajaran Kimia*, 11(3), 38-47.

Silalahi, R. A. F. (2019). Pengembangan Instrument Tes Berbasis HOTS (Higher Other Thinking Skills) Pada Materi Hidrolisis Garam. Skripsi, Pendidikan Kimia, Universitas Negeri Medan, Medan.

Sulistiani, S, & Yusuf M, (2022), Development Of computer Based Test Instrument For Higher Order Thinking Skills (CBT-HOTS) On Chemical Bonding Materials Chemistry Educational Chemisty. *Journal Of educational chemistry* (JEC), 4(1), 31-38

Ulfa, D. K. (2018). Hubungan Motivasi Belajar dan Konsep Diri Siswa dengan Keterampilan Berpikir Tingkat Tinggi pada Materi Stoikiometri untuk Siswa Kelas X Mipa SMA Negeri 4 Surakarta Tahun Pelajaran 2017/2018.

Wijaya, I. (2020). Perancangan dan Metode Pembelajaran karakteristik Pelajaran Jurnal Pti (Pendidikan Informasi) Fakultas Keguruan Ilmu Pendidikan Universita Putra Indonesia" Yptk" Padang, 9-20.

Wiwit, Amir, H., & Putra, D. D. (2014). Penerapan Model Pembelajaran Kooperatif Tipe TGT dengan dan Tanpa Penggunaan Media Animasi terhadap Hasil Belajar Kimia Siswa SMA Negeri 9 Kota Bengkulu. *Jurnal Exacta*, X(1), 71–78.